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Umbilical Scar Position and Sexual Dimorphism in Hog-nosed Snakes, Genus *Heterodon*.

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Incidental to a general study of variability in the hognosed snakes, notes were made on the position of the umbilical scar; these data appeared to indicate a sexual dimorphism when position was indicated either by the number of the most anterior or the most posterior ventral marked by the scar. A preliminary note to this effect was published employing data on *Heterodon platyrhinos* from the southern portion of the range, which, at the time, was thought to be relatively homogeneous in total ventral count (Edgren, 1951). Since 1951 several papers have appeared that also considered this problem: Richmond (1954) showed a sexual difference in number of ventrals both anterior and posterior to the scar in the rainbow snake (*Abastor erythrogrammus*); Peters (1956) demonstrated a sexual difference in plates anterior to the scar, but no significant dimorphism was found in number of plates from the anterior end of the scar posterior to the anal plate in *Dipsas catesbyi*. Martof (1954) showed a sexual difference in the common garter snake (*Thamnophis s. sirtalis*). In the latter species the umbilical scar was situated more posteriorly in males than in females, as was to be expected from the greater total number of ventrals in male garter snakes. Martof also stated that the sexual differences in position of the scar were the same as the differences in total number of ventrals and concluded, "... the position of the umbilicus ... is not another sexual difference but actually is an expression of the ... fact that the number of ventrals is diagnostic of sex in many species of snakes." Similar objections had been voiced by W. T. Stille prior to the publication of the 1951 note. Stille's argument may be summarized as follows: if an arbitrary point be indicated at a given number of ventrals anterior to the vent and the ventrals counted back to that point, the figures obtained would indicate a sexual dimorphism in position of the point. Stille's objections would be valid if the umbilical scar were an arbitrary point, but it is not. Further, Richmond's demonstration of a sexual difference in ventrals posterior to the scar

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invalidated the arbitrary point hypothesis. The present communication further explores the position of the umbilicus in the hog-nosed snakes and suggests that it, together with the position of the vent, reflects a basic sexual dimorphism that probably affects a large number of organs and other morphological landmarks.

The Position of the Umbilical Scar in *Heterodon platyrhinos*

Since publication of the preliminary note approximately 100 more individuals have been examined from which accurate data on umbilical scar position were obtainable. In confirmation of previous data there were more ventrals anterior to the umbilical scar in females than in males ; total ventral counts, of course, were also higher in females (Table 1) . As Martof suggested, the mean sexual differences between umbilical scar positions and between vent positions were similar. Since these data were obtained from specimens from all portions of the range of *platyrhinos*, and there are distinct geographic variations in total ventrals, sampling errors could account for these differences. In order to preclude this remote possibility the apparent linear relationship between ventrals anterior to the scar and total ventrals was studied (Fig. 1) . Initially males and females were treated separately and individual regression lines were calculated. However, as (1) a variance-ratio test indicated no significant difference in variability between males and females ($p > 0.10$) ; (2) a t-test suggested no difference between regression coefficients ($p > 0.40$) ; and (3) the method of Quenouille (1950) disclosed no significant distance between the two lines ($p > 0.10$) , a single pooled regression was applied to the data. The number of ventrals anterior to the umbilicus was highly correlated with the total number of ventrals ($r = 0.913$) .

Thus it seems obvious that the sexual dimorphism apparent in umbilical scar position is related to those conditions producing sexual differences in total number of ventrals, or as Stille and Martof apparently would prefer it, umbilical scar position is controlled by vent position. Most herpetologists assume that the ventrals and caudals bear an important relationship to the number of somites. This assumption suggests two alternate hypotheses:

- a) Total somite number is sexually dimorphic.
- b) Total somite number is not sexually dimorphic ; sexual differences in ventrals and caudals only reflect a differential position of the anal opening relative to the somites.

It is well known that male snakes generally have fewer ventral plates than females, and that they usually have larger numbers of caudals (in a few groups this situation is reversed) . In an attempt to evaluate these hypotheses sexual differences in somite number (ventrals + caudals)

were compared in a series of collections from relatively restricted geographic areas. Although there were marked differences between "populations" in this statistic, only one of the five "populations" tested suggested any sexual dimorphism (Table 2). The second hypothesis seems supported by the data. Thus the well-known sexual differences in total

Table 1. Sexual differences in numbers of ventrals anterior to the umbilical scar and in total ventrals of *Heterodon platyrhinos*.

Ventrals Anterior to Umbilical Scar			
	Range	Mean \pm s.e.	N
Males	90 - 109	101.1 \pm 0.49	73
Females	101 - 120	110.0 \pm 0.53	64
Difference		8.9 \pm 0.72*	
Total Ventrals			
Males	120 - 136	129.2 \pm 0.46	73
Females	127 - 149	139.0 \pm 0.50	64
Difference		9.8 \pm 0.68*	

* $p < 0.01$ that male mean = female mean.

Table 2. Numbers of "somites" (Ventrals + caudals) in various "populations" of *Heterodon platyrhinos*.

Locality	Males		Females	
	N	Mean \pm s.e.	N	Mean \pm s.e.
Florida				
Alachua Co.	11	174.6 \pm 1.20**	7	180.7 \pm 1.50**
Marion Co.	5	176.8 \pm 1.28	5	178.6 \pm 1.12
Michigan				
Muskegon Co.	5	176.8 \pm 1.43	10	176.5 \pm 1.15
Louisiana				
St. James Parish	12	185.3 \pm 0.93	15	185.9 \pm 0.83
New York				
Long Island	17	172.5 \pm 1.12	14	175.7 \pm 1.14

** $p < 0.01$ that male mean = female mean.

numbers of ventrals, and the dimorphism in numbers of ventrals anterior to the umbilicus, would appear to result from an anterior shift of both of these morphological landmarks in males *relative* to females. It seems quite probable that these differences are set down early in embryonic development, especially as the umbilicus is related to the earlier intestinal

portals. This relation to the intestinal portals suggests that position of a number of visceral organs may also be dimorphic. This suggestion was not confirmed by Bragdon (1953) who studied position of a series of organs relative to scute number in the water snake, *Natrix sipedon*. However, Bragdon was unable to demonstrate a sexual difference in total numbers of ventrals in his groups, which suggests that some type of sampling bias may have affected his results. If there is a difference in organ position, then these differential proportions may be only manifestations of much more basic and more important sexual differences in morphogenesis. This relative anterior shift of both umbilicus and vent would, in my opinion, favor the hypothesis of differential proportions rather than Peter's suggestion of structural differences (1956, p. 39) . I believe that neither the vent nor the umbilicus can be considered as more than a morphological landmark for the interpretation of sexual differences in development. In fact, if the vent were actually as obscure as the umbilicus is and the umbilical scar were as obvious as the anus is in snakes, this paper and the 1951 note may well have been on the vent.

The total length of the scar, again measured in terms of numbers of ventrals involved, showed no apparent sexual dimorphism.

Umbilical Scar Position in *H. nasicus* and *H. simus*

Few data are available on the southern and western hognosed snakes, as these species are poorly represented by young specimens in museum collections. In 8 young male *nasicus* the anterior end of the scar involved ventrals ranging from number 105 to 119, mean 112.0 ; in 6 females it ranged from 115 to 128, mean 120.8. Three or four ventral plates were cut by the scar. In *Heterodon simus* 7 males ranged from 89 to 98, mean 95.6 ; and 8 females 103 to 114, mean 106.1. From 2 to 5 ventrals were involved in the males ; 3 to 4 in the females. The mean values for *H. nasicus* were higher than for *platyrhinos* whereas those for *simus* were lower ; total ventrals showed similar species differences. The data were too few for adequate analysis, but they suggested patterns similar to those ;shown by *platyrhinos*.

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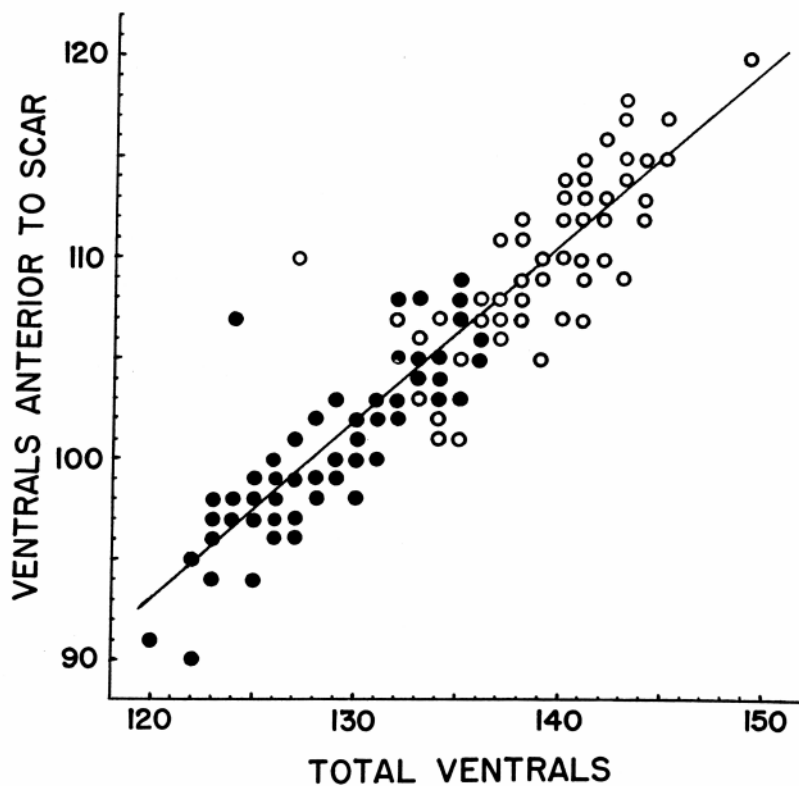


Fig. 1. Regression of number of ventrals anterior to umbilical scar (y) on total number of ventrals (x) in *Heterodon platyrhinos*. Dots, males; circles, females.

$$y = -12.5 + 0.88x$$

$$b = 0.88 \pm 0.0339$$

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